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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/500,494	12/27/2004	Hyung-Sang Park	9907-007	4487

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EXAMINER

PHAM, THANH V

ART UNIT	PAPER NUMBER
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2823

DATE MAILED: 04/18/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No. 10/500,494	Applicant(s) PARK ET AL.	
	Examiner Thanh V. Pham	Art Unit 2823	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☐ Responsive to communication(s) filed on ____.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) ____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) ____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) ____ is/are objected to.
- 8) ☐ Claim(s) ____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☒ The specification is objected to by the Examiner.
- 10) ☐ The drawing(s) filed on ____ is/are: a) ☐ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☒ All b) ☐ Some * c) ☐ None of:
1. ☒ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. ____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- | | |
|--|---|
| 1) <input checked="" type="checkbox"/> Notice of References Cited (PTO-892) | 4) <input type="checkbox"/> Interview Summary (PTO-413)
Paper No(s)/Mail Date. ____. |
| 2) <input type="checkbox"/> Notice of Draftsperson's Patent Drawing Review (PTO-948) | 5) <input type="checkbox"/> Notice of Informal Patent Application (PTO-152) |
| 3) <input type="checkbox"/> Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date ____. | 6) <input type="checkbox"/> Other: ____. |

DETAILED ACTION

Information Disclosure Statement

1. The listing of references in the specification is not a proper information disclosure statement. 37 CFR 1.98(b) requires a list of all patents, publications, or other information submitted for consideration by the Office, and MPEP § 609.04(a) states, "the list may not be incorporated into the specification but must be submitted in a separate paper." Therefore, unless the references have been cited by the examiner on form PTO-892, they have not been considered.

Specification

2. The disclosure is objected to because of the following informalities: on page 4, line 28, "spattering" should be --sputtering--; on page 5, lines 2 and 4, "floure" should be --fluorine--; on page 10, line 20, "tantalum (Ti)" should be --tantalum (Ta)--.

Appropriate correction is required.

3. This application does not contain an abstract of the disclosure as required by 37 CFR 1.72(b). An abstract on a separate sheet is required.

Claim Objections

4. Claims 3 and 13 are objected to because of the following informalities: the term "in place of" should be deleted because **ALD** recited in claim 1 and claim 10 is considered broader than **PEALD** recited in claims 3 and 13 respectively; if not (see MPEP 608.01(n), III. Infringement Test), applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the

claim(s) in independent form. Appropriate correction is required. It is suggested that the whole claim is changed to –the method of claim 1 (or 10), wherein said atomic layer deposition method is a plasma-enhanced atomic layer deposition (PEALD) method--.

5. Claim 8 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. The limitation of “rhenium (Re) or rhenium alloy” is already recited by the limitation of “ruthenium (Ru) or rhenium (Re) or their alloys” in claim 1.

6. Claim 18 is objected to under 37 CFR 1.75(c), as being of improper dependent form for failing to further limit the subject matter of a previous claim. Applicant is required to cancel the claim(s), or amend the claim(s) to place the claim(s) in proper dependent form, or rewrite the claim(s) in independent form. The limitation of “ruthenium (Ru) or ruthenium alloys” recited in claim 10 cannot be changed to another limitation by use of “rhenium (Re) or rhenium alloys are used in place of ruthenium (Ru) or ruthenium alloys” in claim 18 (see MPEP 608.01(n), III. Infringement Test).

Claim Rejections - 35 USC § 112

7. The following is a quotation of the second paragraph of 35 U.S.C. 112:

The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

8. Claim 20 is rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The limitation “forming an adhesion layer on said barrier layer

using ruthenium (Ru) or ruthenium alloys by using an atomic layer deposition method” recited in claim 10 being changed to “in place of ruthenium (Ru) or ruthenium alloys, one of the materials including nickel (Ni), platinum (Pt), osmium (Os), iridium (Ir) or their alloys of said each metal is used for forming a barrier layer” in claim 20 creates ambiguous. One of ordinary skilled in the art could not decide what materials are used for what functions. It is suggested that “in place of ruthenium (Ru) and ruthenium alloys,” is deleted to recite the materials considering the barrier layer only and to get rid of the ambiguousness.

Claim Rejections - 35 USC § 102

9. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(a) the invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for a patent.

10. Claims 10-11, 14 and 16-18 are rejected under 35 U.S.C. 102(a) as being anticipated by Soininen et al. US 6,482,740 B2.

Re claim 10, the Soininen et al. reference discloses in fig. 1 a method for forming copper interconnect comprising: forming a barrier layer 14 on the surface of a patterned insulation layer 6/8/10/12 on a substrate 2/4; forming an adhesion layer 16 on said barrier layer using ruthenium or ruthenium alloys by using an atomic layer deposition method; and forming a copper layer of thin film 18 on the surface of said adhesion layer.

Re claim 11, the barrier layer is TaN.

Re claims 14 and 16-17, said copper is formed using CVD method and/or electroplating method (col. 3, lines 15-36).

Re claim 18, rhenium or rhenium alloys can be used (col. 9, lines 54-60 and col. 11, line 22).

Claim Rejections - 35 USC § 103

11. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

12. Claims 1, 4 and 6-8 are rejected under 35 U.S.C. 103(a) as being unpatentable over Choi US 5,637,533 in combination with Toyoda et al. US 2001/0013617 A1 and Soininen et al. US 6,482,740 B2.

Re claim 1, the Choi reference discloses "generally, a ruthenium oxide layer (RuO₂) is used as a diffusion barrier metal layer in a highly integrated semiconductor device above 256M DRAM, and used as a glue layer of a metal wiring formed of aluminum, tungsten or copper", "in case where the ruthenium oxide layer is formed by the CVD method, impurities are introduced into the ruthenium oxide layer. This increases the resistance value of the layer. In case that PVD is used, the step coverage of the ruthenium oxide layer is poor, and a silicide layer may be formed".

The Choi reference uses an oxide of ruthenium, does not use ALD method.

The Toyoda et al. reference discloses in [0138] "ruthenium is known to be effective as a diffusion barrier (barrier film) against copper... the thermal diffusion of copper into the interlayer insulating film can be prevented".

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the Choi's method with known ruthenium barrier as taught by Toyoda et al. because the ruthenium of Toyoda et al. would provide the device made by the method of Choi with prevention of thermal diffusion of copper into the interlayer insulating film.

The Soininen et al. reference discloses "the manufacture of conductive thin films, preferably comprising one or more of the following elements: *rhenium* (re claim 8), *ruthenium*, osmium ... iridium, nickel ... platinum ... a metal oxide layer by an ALD type process and essentially converting the metal oxide into an elemental metal to provide sufficient conductive for the thin film. A surprising finding related to the present invention is that the film has very good adhesion to the substrate, even after a reduction step" (col. 5, lines 5-25).

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the method/materials of the combination of Choi and Toyoda et al. with depositing by ALD method for the combination (and a further step of reduction for Choi's material) as taught by Soininen et al. because the method/materials of Soininen et al. would convert the ruthenium oxide layer into ruthenium element metal and/or provide the combination with sufficient conductive for the thin film (Soininen et al.'s *rhenium*) and good adhesion.

Re claims 4 and 6-7, the Soininen et al. reference discloses further said copper is formed using CVD method and/or electroplating method (col. 3, lines 15-36).

13. Claims 2-3, 5 and 9 are rejected under 35 U.S.C. 103(a) as being unpatentable over the above combination as applied to claims 1, 4 and 6-8 above, and further in view of Kim et al. US 6,936,535 B2, Koh et al. US 6,720,262 B2 and the following.

The combination of Choi with Toyoda et al. and Soininen et al. discloses substantially all of the instant invention but lacks the atomic ratio of ruthenium or rhenium, PEALD and iodine as a catalyst for copper CVD.

The Kim et al. reference discloses "the reactive metal layer may also be deposited by any method known in the art, such as by PVD, CVD, ALD or plasma enhanced ALD (PEALD) processes" (col. 10, lines 24-26).

The Koh et al. reference discloses "in a first aspect of the present invention, a method of using iodine or bromine as a catalyst in conjunction with a copper CVD method in filling trenches, via holes and contacts without creating undesirable pinch-offs and voids is disclosed and presented" (col. 2 lines 45-53).

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the method of the combination with known PEALD and iodine as a catalyst in conjunction with a copper CVD because plasma enhanced ALD would provide the method with lower temperature process and iodine as a catalyst in conjunction with a copper CVD would provide the method without creating undesirable pinch-offs and voids.

Choice of ratio of elements would have been a matter of routine optimization because ratio of elements is known to affect device properties and would depend on the desired device density on the finished wafer and the desired device characteristics. One of ordinary skill in the art would have been led to the recited ratio of elements through routine experimentation to achieve desired deposition and reaction rates.

14. Claims 12-13, 15 and 19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Soininen et al. as applied to claims 10-11, 14 and 16-18 above, and further in view of Kim et al. US 6,936,535 B2, Koh et al. US 6,720,262 B2 and the following.

The Soininen et al. discloses substantially all of the instant invention but lacks the atomic ratio of ruthenium or rhenium, PEALD and iodine as a catalyst for copper CVD.

The Kim et al. reference discloses "the reactive metal layer may also be deposited by any method known in the art, such as by PVD, CVD, ALD or plasma enhanced ALD (PEALD) processes" (col. 10, lines 24-26).

The Koh et al. reference discloses "in a first aspect of the present invention, a method of using iodine or bromine as a catalyst in conjunction with a copper CVD method in filling trenches, via holes and contacts without creating undesirable pinch-offs and voids is disclosed and presented" (col. 2 lines 45-53).

It would have been obvious to one of ordinary skill in the art at the time of the invention to provide the method of the Soininen et al. with known PEALD and iodine as a catalyst in conjunction with a copper CVD because plasma enhanced ALD would

provide the method with lower temperature process and iodine as a catalyst in conjunction with a copper CVD would provide the method without creating undesirable pinch-offs and voids.

Choice of ratio of elements would have been a matter of routine optimization because ratio of elements is known to affect device properties and would depend on the desired device density on the finished wafer and the desired device characteristics. One of ordinary skill in the art would have been led to the recited ratio of elements through routine experimentation to achieve desired deposition and reaction rates.

Conclusion

15. The prior art made of record and not relied upon is considered pertinent to applicant's disclosure.

16. Any inquiry concerning this communication or earlier communications from the examiner should be directed to Thanh V. Pham whose telephone number is 571-272-1866. The examiner can normally be reached on M-Th (6:30-5:00).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Matthew Smith can be reached on 571-272-1907. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

WJ

04/14/2006

George R. Fourson
GEORGE R. FOURSON
PRIMARY EXAMINER